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Automotive Handbook

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SAE

OBD functions

Whereas EOBD and EPA OBD only prescribe few explicit emission reduction systems and provide detailed monitoring regulations, the specific requirements of the CARB OBD II are much more detailed. A further review was made for the model years from 2004 (OBD I update). The list below shows the current state of the CARB requirements (from model year 2004) for gasoline-engined and diesel-engined passenger cars. (E) identifies the requirements that also apply to EOBD.

- Catalytic converter (E), heated catalytic converter,
- Combustion (misfire) misses (E; diesel system: not for EOBD),
- Evaporation reduction system (tank-leak diagnosis, only for gasoline system),
- Secondary-air injection,
- Fuel system,
- Oxygen (lambda) sensors (E),
- Exhaust-gas recirculation,
- Crankcase ventilation,
- Cooling system,
- Cold-start emission reduction system,
- Air conditioner (components),
- Variable valve timing (at present only for gasoline systems),
- Direct ozone reduction system,
- Particulate filter (soot filter, only for diesel system) (E),
- "Comprehensive components" (E),
- "Other emission-related components" (E).

Some of the components listed here are categorized as "comprehensive components" or "other emission-related components" with EOBD and EPA. These categories have the following meaning:

- Other components or subsystems of the emission reduction system, or
- Emission-relevant components connected to a computer, or
- Drivetrain subsystems, which, if they malfunction or become defective, may result in exhaust-gas emissions exceeding the OBD emission limits or the disabling of other diagnostic functions.

Catalytic converter diagnosis

Gasoline system

This diagnostic function monitors the conversion efficiency of the three-way catalytic converter. This is measured by the catalytic converter's oxygen retention capability. Monitoring is performed by observing the signals from the Lambda oxygen sensors in reaction to a specific alteration of the setpoint value of the lambda closed-loop control.

Additionally, the NO_x accumulation capacity (catalytic-converter quality factor) must be assessed for the NO_x accumulator-type catalytic converter. For this purpose, the actual NO_x accumulator content resulting from consumption of the reduction agent during regeneration of the catalytic converter is compared with an expected value.

Diesel system

In the diesel system, carbon monoxide (CO) and unburned hydrocarbons (HC) are oxidized in the oxidation-type catalytic converter (to minimize pollutants, see P. 718). There is ongoing development on diagnostic functions to monitor the operation of the oxidation-type catalytic converter based on temperature and differential pressure.

At the same time, work is underway on developing monitoring functions for the accumulation and regeneration capabilities of the NO_x accumulator-type catalytic converter that will also be installed in the diesel system in the future.

Combustion-miss detection

A misfire or combustion miss results in an increase in HC and CO emissions. The misfire detector evaluates the time expired (segment time) from one combustion to the next for each cylinder. This time is derived using the speed-sensor signal. A segment time that is longer compared to the other cylinders indicates a misfire.

Fuel injection is disabled at the cylinder concerned if the misfire rates exceed permissible levels (gasoline system).

In the diesel system, diagnosis of combustion misses is only required and performed when the engine is at idle.

gas-filled gap to the ground electrode. As less ignition voltage is required for discharging across the surface than for discharging across an air gap of the same size, the surface-gap spark can bridge bigger electrode gaps than the air gap spark given the same ignition voltage. The resulting larger flame core improves ignition properties considerably.

These spark-plug concepts also have much better repeat cold-starting performance because the surface-gap spark cleans the insulator end-face, or prevents soot from settling there.

Semi-surface gap concepts (c)
In these spark-plug concepts, the ground electrodes are positioned at a specific distance from the center electrode and the end face of the ceramic insulator. Two alternative spark gaps are created as a result, thus allowing both forms of discharge with different ignition voltage requirements. Depending on operating conditions, the spark behaves either as an air-gap spark or a surface-gap spark.

Spark-plug operating performance
Changes in operation
As the spark plug operates in an aggressive atmosphere, sometimes at high temperatures, the electrodes will wear, thus increasing the ignition voltage requirement. When this requirement can no longer be met by the supply from the ignition coil, misfiring will occur.

Dirt and changes in the engine caused by aging (e.g. higher oil consumption) can also affect operation of the spark plug. Deposits on the spark plug can result in shunts, and thus in misfiring. This, in turn, may cause a considerable rise in pollutant emissions, and even damage the catalytic converter. The spark plugs must therefore be replaced at regular intervals.

Electrode wear
Electrode wear is the erosion of electrode material. As a result, the electrode gap grows, the longer the spark plug is in service. There are essentially two mechanisms that are responsible for this:
– Spark erosion
– Corrosion in the combustion chamber

Materials with a high thermal resistance (e.g. platinum and platinum alloys) are used to minimize electrode wear. Material wear can also be reduced for the same period of use, by appropriate selection of electrode geometry and spark-plug concept (surface-gap spark plugs).

The resistor in the conductive glass seal reduces burn-off, and thus helps to reduce wear.

Abnormal operating conditions
Abnormal operating conditions (auto-ignition, combustion knock, etc.) can damage the engine and spark plugs beyond repair.

The engine and the spark plugs my sustain damage due to incorrectly set ignition systems, the use of spark plugs whose heat range is unsuitable for the engine, or the use of unsuitable fuels.

Auto-ignition
Auto-ignition is an uncontrolled ignition process where the temperature in one spot in the combustion chamber (e.g. at the spark-plug insulator nose, at the exhaust valve, or at the cylinder-head gaskets) may rise to such an extent that serious damage is caused to the engine and spark plug.

Combustion knock
Knock is uncontrolled combustion with a very steep pressure rise (see P. 619). The combustion process is considerably faster than normal combustion. Due to high pressure gradients, the components (cylinder head, valves, pistons, and spark plugs) are subjected to high temperature loads. This may result in damage to one or several of the components (see knock control, P. 621).

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